AMPLIFIER RESEARCH
MODEL 10S1G4A

Operations Manual

⚠ INSTRUCTIONS FOR SAFE OPERATION

BEFORE APPLYING POWER

Review this manual and become familiar with all safety markings and instructions.

Verify that the equipment line voltage selection is compatible with the main power source.

Protection provided by the equipment may be impaired if used in a manner not specified by Amplifier Research.

INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications. It is designed to be used in the process of generating, controlling, and measuring high levels of electromagnetic Radio Frequency (RF) energy. Therefore, the output of the amplifier must be connected to an appropriate load, such as an antenna or a field-generating device. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of the RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the amplifier. Do not come into contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating condition before disconnecting or connecting the load to the RF output connector.

SAFETY GROUND

This equipment is provided with a protective earth terminal. The main power source to the equipment must supply an uninterrupted safety ground of sufficient size to the input wiring terminals, power cord, or supplied power cord set. The equipment **MUST NOT BE USED** if this protection is impaired.

PHYSICAL DAMAGE

The RF amplifier should not be operated if there is physical damage, missing hardware, or missing panels.

MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

⚠ INSTRUCTIONS FOR SAFE OPERATION *(CONTINUED)*

SAFETY SYMBOLS

⚠ This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information. This symbol is indicated in the Table of Contents to assist in locating pertinent information.

⚠ Dangerous voltages are present. Use extreme care.

CAUTION: The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction or harm.

⏚ Indicates protective earth terminal.

RANGE OF ENVIRONMENTAL CONDITIONS

This equipment is designed to be safe under the following environmental conditions:

Indoor use

Altitude up to 2000M

Temperature of 5°C to 40°C

Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearity to 50% at 40°C.

Mains supply voltage fluctuations not to exceed ± 10% of the nominal voltage or minimum and maximum autoranging values.

Pollution degree 2: Normally non-conductive with occasional condensation

While the equipment will not cause hazardous condition over this environmental range, performance may vary.

COOLING AIR

Care should be exercised not to block the cooling air inlets or outlets. Cooling air blockage can result in damage to the RF amplifier or intermittent shut-downs.

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SECTION I

GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The Model 10S1G4A is a self-contained, broadband microwave amplifier designed for laboratory applications where instantaneous bandwidth, high gain, and moderate power output are required. A **GAIN** control, which is conveniently located on the unit's front panel, can be used to decrease the amplifier's gain by 10 decibels (dB) or more. Solid state technology is used exclusively to offer significant advantages in reliability and cost. A Model 10S1G4A, used with a frequency-swept signal source, will provide 10 watts of swept power output from 0.8–4.2 gigahertz (GHz). Typical applications include antenna and component testing, wattmeter calibration, and electromagnetic interference (EMI) susceptibility testing, as well as usage as a driver for frequency multipliers and high-power amplifiers. The Model 10S1G4A can be operated locally by using the unit's front panel controls, or remotely by using the unit's IEEE-488 or RS-232 interface.

1.2 POWER SUPPLIES

The Model 10S1G4A contains switching power supplies. The input voltage range to the power supplies is 90–132 or 180–264 Volts Alternating Current (VAC), 50/60Hz, selected automatically. The operator does not have to switch or change anything on the Model 10S1G4A when changing the AC input voltage. AC power consumption is 250 watts nominal. A built-in circuit breaker provides primary AC circuit protection.

1.3 SPECIFICATIONS

Refer to the "Amplifier Research Data Sheet" on the following page for detailed specifications. All voltage measurements referenced in this manual are Direct Current (DC) unless stated otherwise.

SECTION II

OPERATING INSTRUCTIONS

2.1 General Information

Operation of the Model 10S1G4A Broadband Microwave Amplifier is simple. The amplifier's input signal, whether swept or fixed in frequency, is fed into the jack marked **"INPUT,"** and the amplifier's output signal is taken from the jack labeled **"OUTPUT."** The unit is turned "ON" by activating the power switch. Fuses located in the AC input receptacle provide protection in the event of a unit malfunction. A polarized, three (3)-wire AC power cord is also included with the unit to provide cabinet and chassis grounding to the power mains.

⚠ CAUTION:

OPERATION OF THE MODEL 10S1G4A AMPLIFIER IS NOT CRITICALLY AFFECTED BY SOURCE AND LOAD VOLTAGE STANDING-WAVE RATIO (VSWR), AND THE UNIT WILL REMAIN UNCONDITIONALLY STABLE UNDER ANY MAGNITUDE AND PHASE CONDITIONS OF SOURCE AND LOAD. THE MODEL 10S1G4A HAS ALSO BEEN DESIGNED TO WITHSTAND RF INPUT POWER LEVELS AS HIGH AS 20MW—TWENTY (20) TIMES ITS RATED INPUT POWER LEVEL OF 1MW—WITHOUT SUSTAINING DAMAGE. HOWEVER, RF INPUT POWER LEVELS GREATER THAN 20MW OR TRANSIENTS WITH HIGH PEAK VOLTAGES CAN DAMAGE THE AMPLIFIER. ALSO, ACCIDENTAL CONNECTION OF THE MODEL 10S1G4A'S OUTPUT TO ITS INPUT CAN CAUSE OSCILLATIONS THAT WILL PERMANENTLY DAMAGE THE UNIT'S INPUT CIRCUITRY.

IMPORTANT NOTE:

ALTHOUGH THE MODEL 10S1G4A IS DESIGNED TO OPERATE WITHIN THE OVERDRIVE AND LOAD TOLERANCE CONDITIONS DESCRIBED ABOVE, SUBJECTING THE AMPLIFIER TO THESE CONDITIONS SIMULTANEOUSLY CAN CAUSE FAILURE OF THE UNIT'S OUTPUT TRANSISTORS. REPEATED FAILURES OF THIS NATURE WILL NOT BE COVERED UNDER THE UNIT'S WARRANTY.

The Model 10S1G4A Amplifier is protected from input overdrive by an Automatic Level Control (ALC) circuit that limits the maximum RF level to the first gain stage (Q1) of the RF Amplifier to approximately 0dBm.

The Model 10S1G4A's RF power transistors are protected from over-temperature by a sensor that senses the heat sink temperature near the RF output transistors. In the event of a cooling fan failure or an air flow blockage, the DC voltage will be removed from the RF stages; if and when the heat sink temperature reaches approximately 70°C, the vacuum fluorescent display (VFD) on the unit's front panel will indicate **THERMAL FAULT**. Normal operation can be resumed by resetting the amplifier after the heat sink temperature drops below 70°C.

2.2 Amplifier Operation

Figure 2-1 shows the front panel of the Model 10S1G4A Broadband Microwave Amplifier.

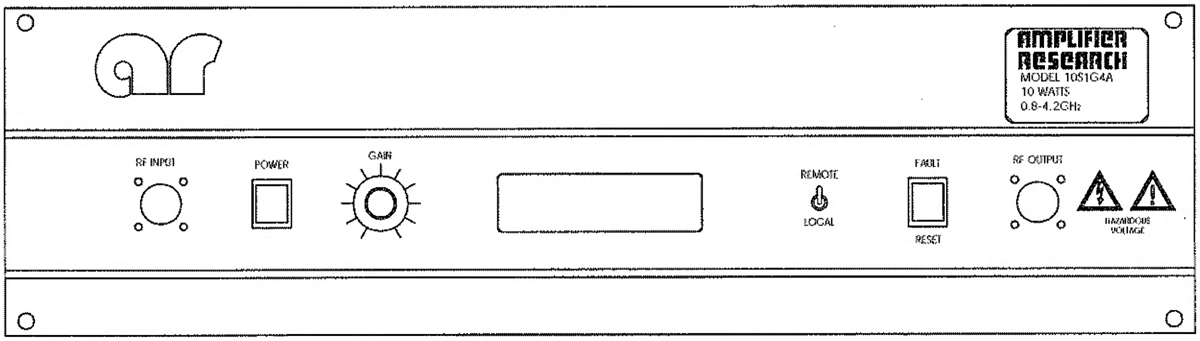

Figure 2-1
Model 10S1G4A Front Panel

Figure 2-2 shows the rear panel of the Model 10S1G4A Broadband Microwave Amplifier.

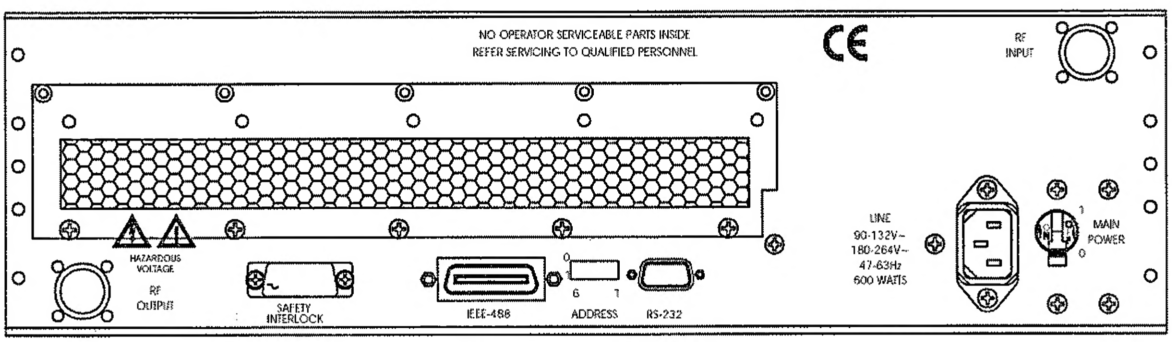

Figure 2-2
Model 10S1G4A Rear Panel

2.2.1 Local Operation

Power-up Sequence:

1. Connect the input signal to the unit's **RF INPUT** connector. **The input signal level should be 0dBm maximum.**

2. Connect the load to the unit's **RF OUTPUT** connector.

3. Set the **REMOTE/LOCAL** switch to **LOCAL.**

4. Check to see that the **MAIN POWER** switch (circuit breaker) on the unit's rear panel is set to the **1** ("on") position.

5. Press the **POWER** switch: the front panel vacuum fluorescent display (VFD) should read **POWER ON, STATUS OK** when power is applied.

   (NOTE: The amplifier changes state each time the POWER switch is depressed—if the unit is on when the POWER switch is depressed, it will turn off; if the unit is off when the POWER switch is depressed, it will turn on.)

6. Adjust the amplifier's gain by rotating the **GAIN** knob.

7. In the event of a fault, press the **FAULT/RESET** switch; if the fault does not clear, refer to subsection **4.3** ("Troubleshooting") of this manual.

2.2.2 Remote Operation

2.2.2.1 Introduction

This subsection describes remote operation of the Model 10S1G4A amplifier by utilizing either the IEEE-488 parallel interface or the RS-232 serial interface and a controlling device, such as a bus controller or a personal computer (PC).

2.2.2.2 Selecting Remote Operation

The Model 10S1G4A can be placed in the remote operation mode at any time by switching the **REMOTE/LOCAL** switch on the front panel to the **REMOTE** position. In this mode, control is transferred to the selected remote interface and all front panel controls are inoperative with the exception of the **REMOTE/LOCAL** switch. The amplifier's initial state will be **Power Off, Minimum Gain**. The front panel VFD will indicate **REMOTE** until the unit is returned to the local operation mode.

2.2.2.3 Interface Selection

The Model 10S1G4A can be controlled via either the IEEE-488 or RS-232 interface; which interface is active is determined by the position of Switch 6 of the rear panel Dual In-Line Package (DIP) switch located between the two interface connectors. If Switch 6 is in the "on" (**1**) position, the RS-232 interface will be active; if Switch 6 is in the "off" (**0**) position, the IEEE-488 interface will be active.

2.2.2.4 Interface Set-up

Switches 1–5 of the rear panel DIP switch are used to select either the RS-232 communication (BAUD) rate or the IEEE-488 device address, depending upon which interface is active. (**Note:** These switches are only read at device power-up. In order for changes made in these switch settings to take place, AC power must be removed and then re-applied to the Model 10S1G4A.)

2.2.2.4.1 RS-232 BAUD rate selection

The serial communication (BAUD) rate can be set to five different levels. Selections are made by the positions of Switches 1–5 of the rear panel DIP switch. The following is a list of the available BAUD rates and the corresponding DIP switch positions:

BAUD Rate	Switch On (1)
1200	1 only
2400	2 only
9600	3 only
19,600	4 only
76,800	5 only

(**Note:** Any other combination of switch settings will result in a BAUD rate equal to 1200.)

2.2.2.4.2 IEEE-488 device address selection

The IEEE-488 device address can be set to any number between 1 and 30. This selection is made by setting Switches 1–5 of the rear panel DIP switch to the binary equivalent of the number. **Table 2-1** illustrates this switch selection.

Table 2-1: IEEE-488 Device Address Selection

Device Address	Switch 5	Switch 4	Switch 3	Switch 2	Switch 1
1	off (0)	off (0)	off (0)	off (0)	on (1)
2	off (0)	off (0)	off (0)	on (1)	off (0)
3	off (0)	off (0)	off (0)	on (1)	on (1)
4	off (0)	off (0)	on (1)	off (0)	off (0)
5	off (0)	off (0)	on (1)	off (0)	on (1)
:					
:					
30	on (1)	on (1)	on (1)	on (1)	off (0)

2.2.2.5 Command Set Format

Each command is composed of one alpha character, up to four numeric parameters, and a command termination character. The command termination character is the "line feed" command, which is denoted and entered as <LF>. Commands are case-sensitive and must be entered in upper case only in order to be recognized.

2.2.2.6 IEEE-488 Communications

For IEEE-488 communications, the "End or Identify" (EOI) control line may also be used for command termination. When sending commands to the Model 10S1G4A via the IEEE-488 bus, terminate each command with a <LF>, an EOI, or both. No characters are permitted after the <LF> or EOI; the 10S1G4A interprets characters following the <LF> or EOI as the start of the next command. When an error condition is present at the Model 10S1G4A, the "Service Request" (SRQ) line is asserted; the operator can then perform a serial poll operation. The Model 10S1G4A error code (in binary) is contained in the returned serial poll status byte (STB). These error codes are defined in **Table 2-2**.

Table 2-2: Remote Error Codes/Messages

IEEE-488 Serial Poll Response (STB) (binary/decimal)	Model 10S1G4A Error Condition	RS-232 Error Message
(01000001) 65	BAD COMMAND	E1
(01000010) 66	BAD PARAMETER	E2
(01000011) 67	INTERLOCK FAULT	E3
(01000100) 68	THERMAL FAULT	E4
(01000101) 69	POSITIVE 15 VOLT FAULT	E5
(01000110) 70	POSITIVE 16 VOLT FAULT	E6
(01000111) 71	NEGATIVE 5 VOLT FAULT	E7
(01001000) 72	NEGATIVE 15 VOLT FAULT	E8
(01001001) 73	AMP FAULT	E9
************	TRANSMISSION ERROR	E10

2.2.2.7 RS-232 Communications

If the RS-232 interface is active, the Model 10S1G4A will test for a properly connected RS-232 interface when it is switched into the remote operation mode. In order for the Model 10S1G4A to recognize an RS-232 connection, the "Data Carrier Detect" (DCD) line must be asserted. This line is sampled continuously to determine if the RS-232 connection is broken; therefore, it must remain asserted in order for the RS-232 interface to function. The "Clear To Send" (CTS) line is also used to gate information from the Model 10S1G4A. This line must be asserted in order to receive information from the Model 10S1G4A. The CTS line can be used as a "handshake" line to inform the Model 10S1G4A when it is permissible to send information. If the CTS line is de-asserted in the middle of a transmission, the character in the process of being transmitted will be completed and further transmission will halt until the CTS line is re-asserted. The Model 10S1G4A itself asserts two lines: "Data Terminal Ready" (DTR) and "Request To Send" (RTS). The DTR line is continuously asserted, while the RTS line is used to gate information into the Model 10S1G4A. Connector pin-out information is given in **Table 2-3**.

Table 2-3: RS-232 Connector Pin-Outs

Pin No.	Signal	Data Direction*	Description
1	DCD	<	Device Carrier Detect
2	RD	<	Receive Data
3	TD	>	Transmit Data
4	DTR	>	Data Terminal Ready
5	GND	N/A	Ground
6	NC	N/A	No Connection
7	RTS	>	Ready To Send
8	CTS	<	Clear To Send
9	NC	N/A	No Connection

***Note:**
> = Output from Model 10S1G4A
< = Input to Model 10S1G4A

Special Note: A null modem cable or adapter is required in order to properly interface the Model 10S1G4A to a standard serial port on a computer.

Once the RS-232 interface is established, commands are processed in the same manner as that of the IEEE-488 interface. The command structure is identical except that there is no EOI line. Therefore, all commands are terminated with a line feed (<LF>). Since this is a full-duplex asynchronous interface, if the Model 10S1G4A detects an error, the error message is immediately transmitted to the host controller. These error messages are defined in **Table 2-2.**

2.2.2.7.1 RS-232 port settings

The RS-232 port settings used for communication with the Model 10S1G4A are as follows.

Word Length: 8 bits

Stop Bits: 1

Baud Rate: 1200–76,800 (switch-selectable)

Parity: None

2.2.2.8 Remote Commands

The following commands are available to the user for remote communication and operation of the Model 10S1G4A. In the descriptions of these commands, a lower-case "x" is used to signify a numeric value or parameter.

2.2.2.8.1 Power On/Off

Controls the power on/off state of the Model 10S1G4A.

Syntax: Px

Parameters: 0 = power off

1 = power on

Example: To turn the power on, send the following command:

P1<LF>

2.2.2.8.2 Gain

Sets the remote gain level of the Model 10S1G4A with 4095 steps of resolution.

Syntax: Gxxxx

Parameters: 4095 = maximum gain

:

:

0000 = minimum gain

Example: To set the Model 10S1G4A to minimum gain, send the following command:

G0000<LF>

2.2.2.8.3 Reset

Resets the Model 10S1G4A, clearing all faults, if possible.

Syntax: R

Parameters: None

Example: To clear a fault, send the following command:

R<LF>

SECTION III

THEORY OF OPERATION

3.1 INTRODUCTION

The Model 10S1G4A Microwave Amplifier consists of a 0.8–4.2GHz RF Amplifier located on the heat sink and a Power Supply/Operate/Fault circuit mounted on a chassis assembly located opposite the heat sink. The RF Amplifier assembly can be accessed through the top of the unit, and the Power Supply and Operate/Fault circuits can be accessed through the bottom of the unit.

The RF Amplifier assembly consists of a Variable Gain Amplifier/Detector, a Linearizer/Control circuit, a one (1)-watt amplifier, a Bias Control circuit, a two-way splitter, three output Quadrature-Coupled Amplifiers ("Quad Amps"), and a two-way combiner.

The Power Supply section consists of an AC input filter, a circuit breaker, two switching power supplies, an Operate/Control circuit, and a Regulator/Fault circuit.

3.2 RF AMPLIFIER OPERATION

3.2.1 A1 Variable Gain Amplifier (Schematic Diagram No. 1012338—Part of Schematic Diagram No. 1012408)

The RF input signal is fed to the A1 Variable Gain Amplifier, RF Attenuator U1. U1 is a Gallium Arsenide (GaAs) Field-Effect Transistor (FET) Attenuator. DC signals between approximately -0.5V to -2.0V are used to control the shunt and series legs of the RF Attenuator. This Attenuator is used for manual gain control using the front panel **GAIN** control or for remote gain control, and to attenuate RF input signals above 0dBm, by utilizing internal voltages.

Inductor–Capacitor (LC) networks C2, L1, C3, and L2 form high-pass filters that are used to attenuate low-frequency signals.

Transistor Q1 is a GaAs FET and is the first stage of gain in the amplifier. Transistor A2Q1 in the A2 Linearizer Control Circuit controls the drain current through FET Q1. The output of Q1 is fed to the input of the Wilkinson Two-Way Splitter.

The Wilkinson Two-Way Splitter splits the signal into two paths: one output is fed to the input of the A3 One (1)-Watt Amplifier; the other output is fed to a detector that is terminated in 50Ω. The detected output is fed to the A2 Linearizer Control Circuit.

3.2.2 A2 Linearizer Control Circuit (Schematic Diagram No. 1012338—Part of Schematic Diagram No. 1012408)

Integrated circuit (IC) U1A provides a DC signal to the series element of the A1U1 Attenuator. The A1U1 Attenuator has minimum attenuation when the control signal is at approximately -12.5V, with maximum attenuation (minimum gain) occurring with 0V on the control input.

NPN transistors Q2, Q3, and Q4 are used to provide break points in the series control voltage to the A1U1 RF Attenuator, thereby providing a more linear gain control/attenuation characteristic.

PNP transistor Q1 is used to control the drain current of GaAs FET A1Q1 by varying the A1Q1 gate voltage. A reference voltage is provided at the base of Q1 by voltage dividers R25 and R26. The drain current of the RF FET (A1Q1) flows through R27 (220Ω, 1 watt). PNP transistor Q1 varies the gate voltage to the RF FET A1Q1 to maintain the correct drain current.

IC U2A amplifies the signal from the A1CR1 detector diode. IC U2B is a comparator; its normal output is approximately -12.5V. When the RF input signal to the A1 Variable Gain Amplifier is increased above approximately 1mW (0dBm), the voltage output from U2B will become less negative. This voltage is fed to the **GAIN** control on the front panel of the amplifier. The wiper of the **GAIN** control is connected to the control input of U1A of the Linearizer/Control Circuit. The amplifier has maximum gain at approximately -12.5V control input; minimum gain occurs at 0V. The attenuation of A1U1 will increase as the output of A2U2B varies from -12.5V toward 0V. This will help to protect the unit in the event of input overdrive.

3.2.3 A3 One (1)-Watt Amplifier (Schematic No. 1010591—Part of Schematic No. 1010749)

The A3 One (1)-Watt Amplifier is assembled on a Teflon®/glass printed wiring board (PWB). It has three (3) GaAs FET gain stages; each stage is input and output DC isolated by coupling capacitors. Resistive feedback is used from the drain to the gate of the GaAs FET to decrease the low-frequency gain. Shunt capacitive stubs are used to tune the amplifier. The drain of Q4 is matched to the output using a tapered transformer.

The GaAs FETs are operated in a depletion mode. They will conduct the maximum DC current with 0V bias on their gates and are normally operated with approximately -1V to -4V on their gates.

3.2.4 A4 Bias Control Circuit (Schematic No. 1010902—Part of Schematic No. 1010749)

The Bias Control Circuit controls the DC drain current of the three (3) FET stages in the A3 One (1)-Watt Amplifier by varying the gate voltage of the RF stages. The Bias Control Circuit has a -5V input and a +16.5V input from the power supply.

All of the Bias Control Circuit stages operate in a similar manner; therefore, only the operation of the Q4 stage is described herein.

PNP transistor Q4 (2N3906) is used to control the DC current through the A4Q3 FET in the A3 One (1)-Watt Amplifier. A reference voltage of 905V is established on the base of Q4 with the voltage divider network R7 (2.2K) and R12 (3.0K). There is a 18Ω resistor from the 16.5V line to the emitter of Q4 and also to the drain of A3Q3 in the A3 One (1)-Watt Amplifier. Q4 will operate normally with approximately 8.4V on the emitter; this will occur with approximately 440mA through the 18Ω resistor R8. If the current through A4Q3 decreases, the drop across R8 will decrease, thereby increasing the emitter voltage of Q4; this will cause Q4 to conduct more, which will cause the gate voltage of A3Q3 to become more positive, which will cause A3Q3 to conduct more, thereby returning the voltage at the emitter of Q4 to 10.2V.

3.2.5 A5, A7, and A8 Quadrature-Coupled Amplifiers ("Quad Amps") (Schematic No. 1011064)

IC U1 is a voltage regulator set to 13.5V output with a current limit of approximately 2.2 amps. Q1 turns off the voltage regulator when the -5V supply voltage falls below approximately -3.5V. PNP transistors Q2 and Q5 regulate the DC current through Q3 and Q4, respectively, by sensing the voltage drop across 2.7Ω resistors R5 and R16 and varying the negative voltage on the gates of Q3 and Q4, thereby maintaining the drain current at approximately 1 amp. The DC operation of Q3 and Q4 can be checked on Test Point 1 (TP1) and Test Point 2 (TP2) without removing the unit's lid. The normal voltage on TP1 and TP2 without RF drive is 10.9 ±0.4V.

U2 and U3 are 90° quadrature couplers: U2 splits the input signal into two signals with a phase difference of 90°; U3 combines the RF outputs from Q3 and Q4 and is connected to the output connector J2. 50Ω termination resistors R17 and R18 absorb any difference signals and help to improve the input and output VSWR of the module. The module has a gain of 7.5dB or greater and delivers approximately 8 watts of RF power.

IC U4 is a quad comparator that senses if the drain voltage of Q3 or Q4 varies above or below the normal operating range. If the drain voltage of either Q3 or Q4 should fall below +7.0VDC, or if it should rise above +12.6VDC, the output of U4 will drop low and the Amplifier Fault LED (DS1) will light.

3.2.6 A6 Splitter

A6 is a multi-section, broadband Wilkinson splitter. The input signal is split into two equal-amplitude, in-phase signals. The amplitude of each output signal is 3–3.5dB below the input signal when terminated into 50Ω loads.

3.2.7 A9 Combiner

A9 is a multi-section, broadband combiner: the outputs of the A7 and A8 Quad Amps are combined in A9 to yield a total power output approximately 3dB above the output of a single amplifier. The output of A9 is connected to the output connector of the Model 10S1G4A.

3.3 Power Supply Assembly (Schematic Diagram No. 1009563)

The Power Supply Assembly consists of two switching power supplies: PS1 and PS2. These power supplies have a regulated output and auto-ranging on their inputs that automatically selects the correct connections for the line voltage in use, either 90–132 or 180–264VAC, 50/60Hz.

PS1 is a triple-output power supply that provides +5V, +12V, and -12V to power the Operate/Control Board. PS2 is also a triple-output power supply that provides +16.5V to the FET drain supplies in the One (1)-Watt and Quadrature-Coupled amplifiers. PS2 also provides +24V and -24V power supplies. The +24V power supply powers the cooling fans; it is also regulated to +15V to operate the A2 Linearizer Control Board. The -24V power supply is regulated to -15V to operate the A2 Linearizer Control Board; it is also regulated to -5V to provide bias for the GaAs FETs in the One (1)-Watt and Quadrature-Coupled amplifiers. Relay K1 switches the AC input power to PS2 for local and remote amplifier operation. Fans B1 and B2 supply air flow to cool the heat sink and the power supplies.

3.3.1 A10 Operate/Control Board (Schematic Diagram No. 1008597)

The A10 Operate/Control Board is a microcontroller-based printed wiring board (PWB) assembly that allows sensing and control of internal signals as well as remote personal computer (PC) control via on-board RS-232 and IEEE-488 data communications ports. The A10 Operate/Control Board utilizes a state-of-the-art, Reduced Instruction Set Computing (RISC) microcontroller that can quickly and reliably perform all front panel control and monitoring tasks, thereby allowing real-time control of the Model 10S1G4A via either remote bus. Besides being reported remotely, all amplifier faults are continuously monitored and indicated via the front panel VFD.

3.3.2 A11 Regulator/Control Board (Schematic Diagram No. 1009511)

The A11 Regulator/Control Board is comprised of DC regulators, comparators, and relays.

3.3.2.1 Relays K1, K2, and K3 are energized by the A10 Operate/Control Board whenever the Model 10S1G4A is turned on, either locally or remotely. When energized, these relays supply DC power to ICs U1, U3, and U6 and Relay K1 in the Power Supply Assembly.

3.3.2.2 IC U1 supplies +15V to the A2 Linearizer Control Circuit. IC U6 supplies -15V to the A2 Linearizer Control Circuit. IC U3 supplies -5V to all of the Quad Amps and the A3 One (1)-Watt Amplifier.

SECTION IV

MAINTENANCE

4.1 General Maintenance Information

The Model 10S1G4A is a relatively simple instrument that should require very little maintenance. It is built with printed wiring boards (PWBs) and solid state components in order to ensure long, trouble-free life. However, should a malfunction occur, special care must be taken when servicing the unit in order to avoid damaging the solid state components or the PWBs.

Since the unit's solid state components are soldered in place, substitution of components should not be resorted to unless there is some indication that they are faulty. In addition, care must be taken when troubleshooting to avoid shorting amplifier voltages. Small bias changes may cause excessive dissipation or transients that could ruin the amplifier.

All components utilized in Amplifier Research instruments are conservatively operated to ensure maximum instrument reliability. Despite this, parts within an instrument may fail. In most cases, the instrument may be repaired immediately with a minimum of "down time." A systematic approach to troubleshooting can greatly simplify and thereby speed up the required repairs.

However, due to the critical importance of maintaining the amplifier's alignment, it is recommended that the unit be returned to the factory for part replacement and amplifier realignment whenever failure is caused by a breakdown of any of the components in the amplifier's RF signal circuits. Shipping instructions are as follows.

Please ship the unit **PREPAID** via United Parcel Service (UPS) to:

Amplifier Research Corporation
160 School House Road
Souderton, PA 18964-9990 USA

4.2 Disassembly Procedures

⚠ **CAUTION:**

EXTREME CAUTION SHOULD BE UTILIZED WHEN TROUBLESHOOTING THIS UNIT, PARTICULARLY WHEN MEASURING VOLTAGES IN THE POWER SUPPLY SECTION, SINCE HAZARDOUS VOLTAGES EXIST IN THE UNIT THAT COULD CAUSE SERIOUS INJURY TO ANY PERSONNEL PERFORMING THE MEASUREMENTS.

The amplifier can be removed from its housing by removing four (4) screws from the front panel and four (4) screws from the back panel. The amplifier can then be slid from its housing. The top cover can be removed to gain access to the RF assemblies; the bottom cover can be removed to gain access to the power supplies.

4.3 TROUBLESHOOTING

⚠ CAUTION:

THE MICROWAVE TRANSISTORS USED IN THE MODEL 10S1G4A AMPLIFIER ARE GAAS FETS. THESE DEVICES ARE VERY RELIABLE WHEN INSTALLED IN A SUITABLE CIRCUIT, BUT THEY CAN BE EASILY DAMAGED BY IMPROPER TROUBLESHOOTING OR HANDLING TECHNIQUES. THE GATE JUNCTIONS OF THE GAAS FETS HAVE A HIGH INPUT IMPEDANCE AND ARE SUSCEPTIBLE TO STATIC DAMAGE OR DAMAGE DUE TO THE USE OF AN UNGROUNDED SOLDERING IRON. DO NOT TRY TO CHECK THE GAAS FETS WITH AN OHMMETER. USE CAUTION WHEN TROUBLESHOOTING THE GAAS FETS; DO NOT SHORT THE GATE TO THE GROUND OR TO THE DRAIN.

⚠ CAUTION:

USE CARE WHEN UNPACKING NEW GAAS FETS. THE GAAS FET PACKAGING SHOULD ONLY BE OPENED AT ELECTROSTATIC DISCHARGE (ESD)-APPROVED WORKSTATIONS, BY INDIVIDUALS WHO ARE FAMILIAR WITH THE HANDLING OF MICROWAVE GAAS FETS AND OTHER ESD-SENSITIVE DEVICES.

Troubleshooting the Model 10S1G4A in a logical manner can speed the solution to a problem. The settings of potentiometers ("pots"), capacitors ("caps"), or other variables should not be disturbed until other problems have been eliminated. Comparing the measured DC voltages to those shown on the schematics can solve many problems. Before measuring circuit voltages, first verify that the voltages to the circuits are correct.

Model 10S1G4A Troubleshooting Categories:

Subsection 4.3.1—"Power On" Indication Doesn't Display on Front Panel when **POWER** Switch is Depressed

Subsection 4.3.2—The Unit Cannot be Operated Remotely

Subsection 4.3.3—Thermal Fault

Subsection 4.3.4—Interlock Fault

Subsection 4.3.5—Voltage Faults

Subsection 4.3.6—Amplifier Faults

Subsection 4.3.7—Low or No Power Output (DC Tests)

Subsection 4.3.8—Low or No Power Output (RF Tests)

4.3.1 "POWER ON" INDICATION DOESN'T DISPLAY ON FRONT PANEL VACUUM FLUORESCENT DISPLAY (VFD) WHEN POWER SWITCH IS DEPRESSED (SCHEMATIC DIAGRAM NO. 1009563)

4.3.1.1 If the Model 10S1G4A is operating in an otherwise normal fashion, the front panel VFD or the wiring to it could be defective.

4.3.1.2 Check the **LOCAL/REMOTE** switch on the unit's front panel; it must be set to the **LOCAL** position in order to operate the front panel **POWER** switch. Check the circuit breaker on the unit's rear panel; it must be set to the "**I**" ("ON") position.

4.3.1.3 If the **"Power On"** indication is not displayed and the cooling fan (Blower B1) is not running, check to see that the unit is plugged into a live outlet and that the AC line cord is plugged securely into the unit.

4.3.1.4 Check the output voltages from PS1; these voltages should be as follows:

PS1 J2, Pin 1	+12.0 ± 0.3VDC
PS1 J2, Pin 2	+ 5.0 ± 0.2VDC
PS1 J2, Pin 6	+12.0 ± 0.3VDC

4.3.1.5 If output voltages are not present on PS1, check the AC input to PS1.

4.3.1.6 Check the voltages to the A10 Operate/Control Board on connector A10 J1; the voltages should be as follows:

A10 J1, Pin 16	-12.0 ± 0.3VDC
A10 J1, Pin 29	+ 5.0 ± 0.2VDC
A10 J1, Pin 31	+12.0 ± 0.3VDC

4.3.1.7 Check the voltage on A10 J1, Pin 6; it should be ≥4V when the **POWER** switch (S1) is in the normal position and <0.1V when S1 is depressed. S1 is normally open; it is closed only when it is depressed. The amplifier should change state every time the **POWER** switch is depressed.

4.3.1.8 If all voltages are correct and the unit still does not operate, contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.2 The Unit Cannot be Operated Remotely

4.3.2.1 Verify that the front panel **LOCAL/REMOTE** switch is set to the **REMOTE** position.

4.3.2.2 Verify that the unit operates locally by resetting the **LOCAL/REMOTE** switch to the **LOCAL** position; if the unit does not operate locally, see subsection **4.3.1** of this manual.

4.3.2.3 Check the position of the **"ADDRESS"** switch assembly (SW1) on the A10 Operate/Control Board; this assembly can be accessed through the unit's rear panel. Check to see that these switches are properly set for either RS-232 or IEEE-488 operation, as desired.
(See subsection **2.2.2** of this manual for the proper **"ADDRESS"** switch settings.) (**Note:** Address switches are only read at unit power-up; remove and re-apply AC power (i.e., reset the circuit breaker) after changes are made.)

4.3.3 Thermal Fault (Schematic Diagram No 1009563)

During a Thermal Fault, the front panel VFD should read **"Thermal Fault."**

4.3.3.1 Try to reset the unit; if the unit resets and operates normally, check to see that the cooling fan (B1) is operating normally and that the air inlet on the bottom of the unit and the air outlets on the rear of the unit are not blocked.

4.3.3.2 If the unit does not reset and the cooling fan is operating normally, check the voltage at the A10 Operate/Control Board, J1, Pin 4; it should be ≤0.1V.

4.3.3.3 If the voltage on A10 J1, Pin 4 is high, check the thermal daisy chain through S1 to ground.

4.3.4 Interlock Fault (Schematic Diagram No. 1009563)

The Model 10S1G4A is equipped with an interlock connector, which is located on the rear panel. The interlock circuit can be used to sense the openings of doors to screen rooms, test chambers, and so forth, and to turn off RF energy when these doors are opened.

Note: The Model 10S1G4A is shipped with a mating connector, which has a jumper between Pins 1 and 8, installed in the rear panel interlock connector. The unit will not operate unless the interlock circuit is closed.

4.3.4.1 In the event of an Interlock Fault, the front panel VFD should read **INTERLOCK FAULT.**

4.3.4.2 Check to see if it is safe to be power up the unit—are there personnel present in the screen room, or are doors to the screen room open?

4.3.4.3 After checking for safety, try to clear the Interlock Fault from the front panel by using the **RESET** switch.

4.3.4.4 If the Interlock Fault will not clear, check for continuity in the External Interlock Circuit (Pin 1 to Pin 8 in the connector, which mate with J2 in the rear panel).

4.3.4.5 Check the voltage on A11 J1, Pin 18; it should be ≥4.0V.

4.3.4.6 Check the voltage on A10 J1, Pin 20; it should be ≥4.0V.

4.3.4.7 If all of the above voltages are correct and the unit still will not reset, check for defective wiring and/or PWB connections, then try the **RESET** switch again. If the unit still will not reset, the A10 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.5 Voltage Faults (Schematic Diagram Nos. 1009563 and 1009511)

The Model 10S1G4A's fault circuits sense four voltage faults: **-5V, -15V, +15V, and +16.5V**. The -5V and -15V fault circuits are located on the A11 Regulator Control Board. The +15V and +16.5V fault circuits are located on the A10 Operate/Control Board.

4.3.5.1 -5V Faults: -5V faults are sensed by a fault circuit on the A11 Regulator/Control Board.

4.3.5.2 A11 U5B is a comparator that is used to sense -5V faults. This comparator's output is usually low.

4.3.5.3 The output of A11 U5B should go high if the -5V power supply ≤ 3.8V.

4.3.5.4 The output of A11 U5B is fed to the A10 Operate/Control Board via A10 J1, Pin 25.

4.3.5.5 If the output of A11 U5B is low and the -5V fault cannot be cleared, and the amplifier cannot be reset, then the A10 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.5.6 -15V Faults: -15V faults are sensed by a fault circuit on the A11 Regulator/Control Board.

4.3.5.7 A11 U5A is a comparator that is used to sense -15V faults. This comparator's output is usually low.

4.3.5.8 The output of A11 U5A should go high if the-15V power supply is ≤-12.2V.

4.3.5.9 The output of A11 U5A is fed to the A10 Operate/Control Board via A10 J1, Pin 40.

4.3.5.10 If the output of A11 U5A is low and the -15V fault cannot be cleared, and the amplifier cannot be reset, then the A10 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.5.11 +15V Faults: +15V faults are sensed by a fault circuit on the A10 Operate/Control Board.

4.3.5.12 If there is a +15V fault that cannot be cleared, check the voltage at A10 J1, Pin 9. If the voltage is >12.7V and the fault will not clear, check the adjustment of R22 on the A10 Operate/Control Board. If the problem cannot be corrected by adjusting R22, then the Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.5.13 +16.5V Faults: +16.5V faults are detected by a fault circuit on the A10 Operate/Control Board.

4.3.5.14 If there is a +16.5V fault that cannot be cleared, check the voltage on A10 J1, Pin 10. If the voltage is >12.7V and the fault will not clear, check the adjustment of R23 on the Operate/Control Board.

4.3.5.15 If the voltage on A10 J1, Pin 10 is normal (>12.7V) and the fault cannot be cleared by adjusting R23, then the A10 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.6 Amplifier Faults (Schematic Diagram Nos. 1009563, 1009511, and 1009163)

4.3.6.1 The individual fault outputs for the three Quadrature-Coupled Amplifiers ("Quad Amps") (A5, A7, and A8) are sensed on the A11 Regulator/Control Board. If an Amplifier Fault is sensed on the A11 Regulator/Control Board, a high output signal is fed to the A10 Operate/Control Board via A10 J1, Pin 41.

4.3.6.2 The amplifier's top cover can be removed to allow access to the Quad Amps.

4.3.6.3 The Amplifier Fault LED (DS1) should be lit, indicating which Quad Amp(s) has failed.

4.3.6.4 Verify the correct voltages to the Quad Amps. Troubleshoot any incorrect voltages.

C1 = +16.5 ± 0.5V
C4 = -5.0 ± 0.4V

4.3.6.5 Verify the correct voltages on TP1 (C21) and TP2 (C22) of the Quad Amp; the voltage on both Test Points should be 10.4 ± 0.3V.

4.3.6.6 If all input voltages and Test Point voltages on the Quad Amps are correct, and the Amplifier Fault still cannot be cleared, check the Amplifier Fault output on the A11 Regulator/Control Board. The output of A11 J2, Pin 16 should be low if there is no Amplifier Fault; it should go high if there is an Amplifier Fault.

4.3.6.7 If the output of A11 J2, Pin 16 is low and the Amplifier Fault cannot be cleared, and the amplifier cannot be reset by pressing the front panel **RESET** key, then the A10 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A10 Operate/Control Board.

4.3.7 Low or No Power Output (DC Tests) (Schematic Diagram No. 1009563)

All indicators on the Model 10S1G4A are normal, the front panel vacuum fluorescent display (VFD) reads **"Power On,"** and the cooling fan (Blower B1) is operating.

4.3.7.1 Check the position of the RF Gain control—is it set to maximum gain?

4.3.7.2 Check the RF input to the unit—is it the correct amplitude and frequency?

4.3.7.3 Check the RF output connection from the unit—is it correctly connected to the load? Is the coaxial cable okay?

4.3.7.4 Check the voltages on Connector J1 of the A2 Linearizer Control Circuit. Troubleshoot any incorrect voltages.

A2 J1, Pin 4	-15 ± 0.4V
A2 J1, Pin 5	15 ± 0.4V
A2 J1, Pin 6	-12.5 ± 1.5V (RF Gain control at maximum gain, input signal <-5dBm).

4.3.7.5 Check the voltages on the feed-through capacitors of the A1 Variable Gain Amplifier with the RF Gain control set for maximum gain. Troubleshoot any incorrect voltages.

A1 C12	-0.7 to -3.5V
A1 C13	4.3 ± 0.5V
A1 C11	-0.1 ± 0.05V
A1 C10	-1.5 ± 0.5V
A1 C9	-4.0 ± 1.0V

4.3.7.6 Check the voltages supplied to the A4 Bias Control Board. Troubleshoot any incorrect voltages.

A4, Pin 3	16.5 ± 0.5V
A4, Pin 1	-5 ± 0.4V

4.3.7.7 Check the voltages on the feed-through capacitors of the A3 One (1)-Watt Amplifier. Troubleshoot any incorrect voltages.

A3 C3, C5, C7	-0.7 to -3.5V
A3 C4	7.6 ± 0.5V
A3 C6	10.2 ± 0.5V
A3 C8	10.2 ± 0.5V

4.3.7.8 Check the voltages on TP1 (C21) and TP2 (C22) on the A5, A7, and A8 Quad Amps; the voltage should be 10.4 ± 0.3V. If any of the voltages on TP1 and TP2 are low, check the voltages on C1 and C4 of that amplifier.

TP1, TP2	10.9 ± 0.3V
C1	16.5 ± 0.3V
C4	-5 ± 0.3V

4.3.8 Low or No Power Output (RF Test) (Schematic Diagram No. 1009563)

Note: The DC Tests specified in subsections **4.3.7.1–4.3.7.8** should be completed before conducting the RF tests specified in the following subsections.

Phase matching must be maintained from the input of the A6 Two-Way Splitter to the output of the A9 Two-Way Combiner; if coaxial cables are removed, they must be reinstalled in the same locations from which they were removed. Replacement coaxial cable assemblies must be the same lengths as the original ones.

4.3.8.1 The Model 10S1G4A's typical Gain Response is shown in **Figure 4.3.8.1**. The actual gain may vary considerably from that shown in Figure 4.3.8.1, but it should be **≥40dB**.

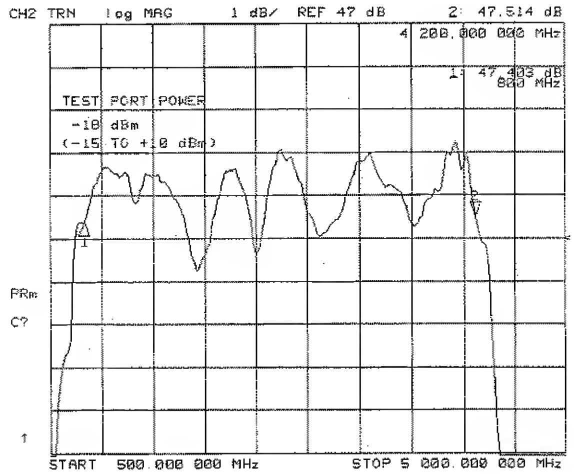

Figure 4.3.8.1
Typical Gain Response: Model 10S1G4A Amplifier

NOTE: If the overall gain is low, the amplifier chain can be separated at the input to the A6 Two-Way Splitter and the gain checked from the input to the A6 Two-Way Splitter to the **RF OUTPUT** connector on the unit's front panel.

4.3.8.2 Remove the coaxial cable from the output of the A5 Quad Amp to the input of the A6 Two-Way Splitter. The typical response from the input of the A6 Two-Way Splitter to the **RF OUTPUT** connector on the unit's front panel is shown in **Figure 4.3.8.2**.

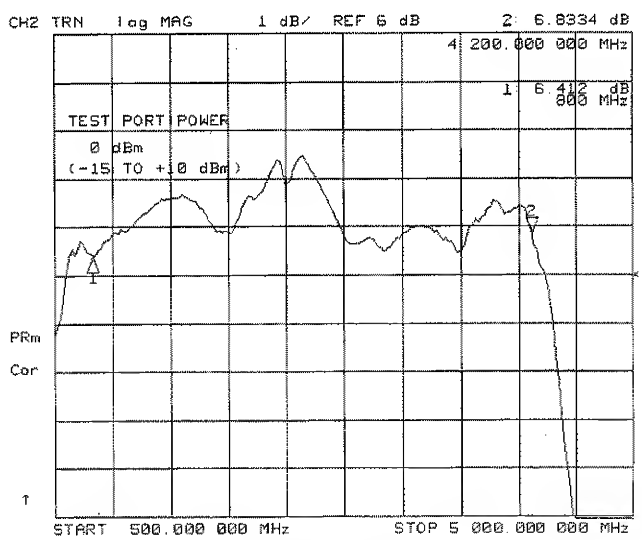

Figure 4.3.8.2
Typical Response: Input A6–Front Panel RF Output

If the response is normal, see subsection **4.3.8.7**. If the response is abnormal, perform the following tests.

4.3.8.3 If the gain is slightly low (i.e., several dB below typical), try disconnecting the inputs from the A7 and A8 Quad Amps one at a time, then reconnect them. Note the difference in response when disconnecting the Quad Amps; if any Quad Amp causes less of a change in gain than the other, check the Quad Amp, coaxial cable, and so forth associated with that Quad Amp. Typical Quad Amp Response is shown in **Figure 4.3.8.3**.

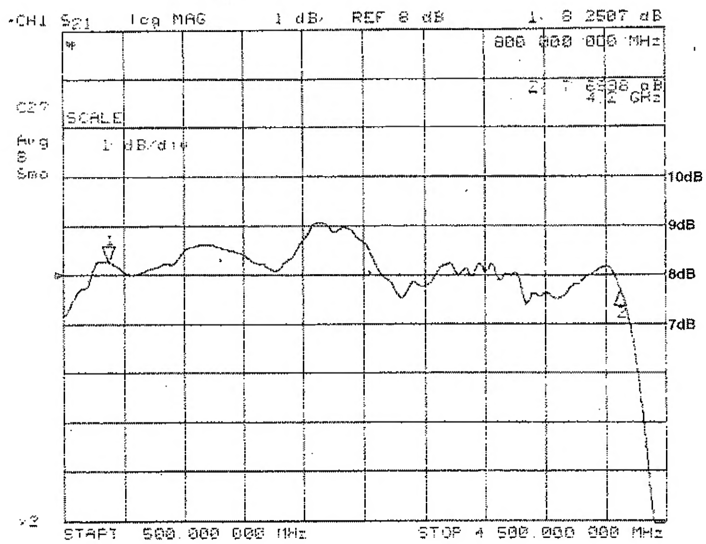

Figure 4.3.8.3
Typical Quad Amp Response

4.3.8.4 If the response of the A7 and A8 Quad Amps is normal, check the A6 Two-Way Splitter and the A9 Two-Way Combiner.

4.3.8.5 A typical Two-Way Splitter Insertion Loss is shown in **Figure 4.3.8.5**. The unused ports must be terminated when checking the insertion loss.

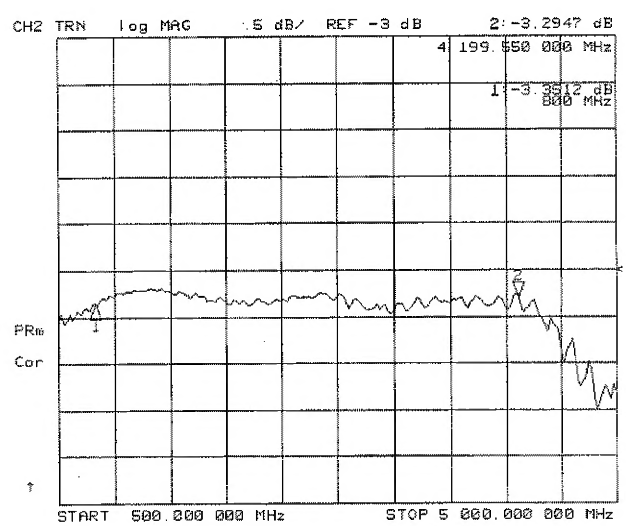

Figure 4.3.8.5
Typical Two-Way Splitter Insertion Loss

4.3.8.6 A typical Two-Way Combiner Insertion Loss is shown in **Figure 4.3.8.6**; a typical Combined Port Return Loss is shown in **Figure 4.3.8.6a**. The unused port must be terminated when checking the insertion loss.

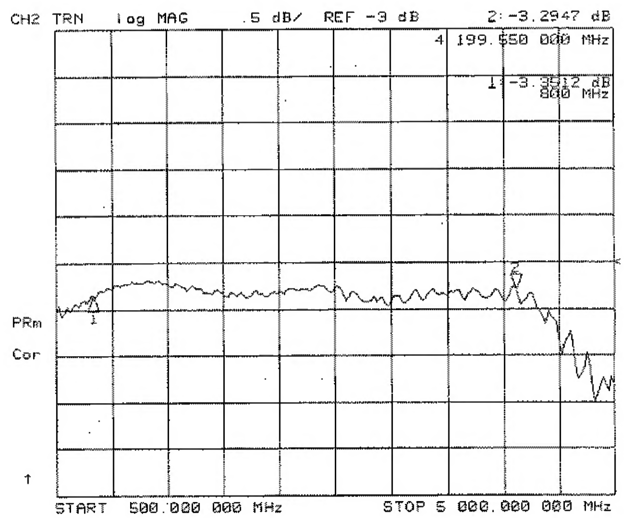

Figure 4.3.8.6
Typical Two-Way Combiner Insertion Loss

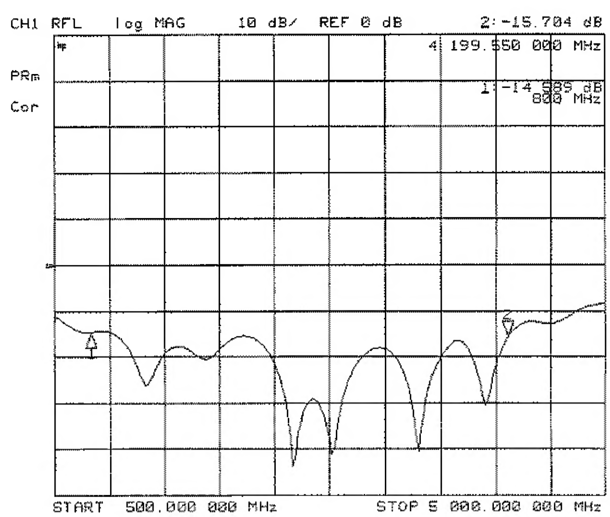

Figure 4.3.8.6a
Typical Two-Way Combiner Return Loss: Combined Output Port

NOTE: The Return Loss of the Two-Way Combiner's combined output port is typically better than **15dB** (see **Figure 4.3.7.6a**).

4.3.8.7 If the response of the output stages (i.e., A6 Two-Way Splitter input to front panel RF Output) is normal, check the response of the A5 Quad Amp (see **Figure 4.3.8.7**).

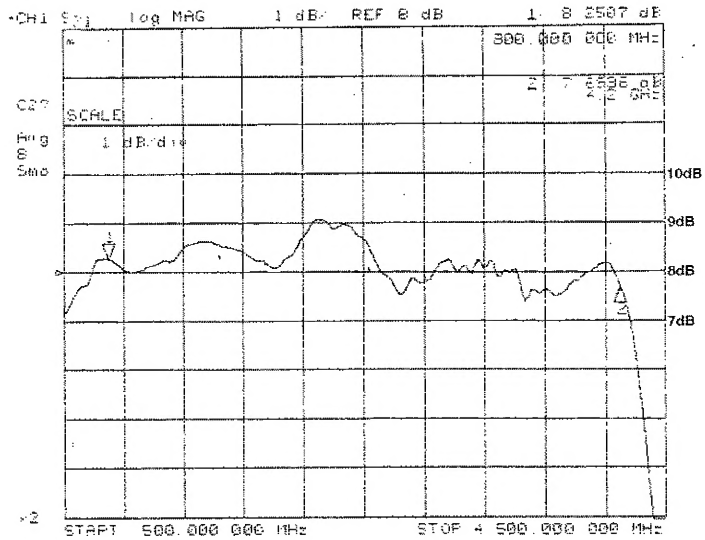

Figure 4.3.8.7
Typical Quad Amp Response

NOTE: The A3 One (1)-Watt Amplifier's response or the A1 Variable Gain Amplifier's response may differ considerably—particularly in flatness—from the typical responses shown in **Figure 4.3.8.8** and **Figure 4.3.8.9.**

4.3.8.8 The typical response for the A3 One (1)-Watt Amplifier is shown in **Figure 4.3.8.8.**

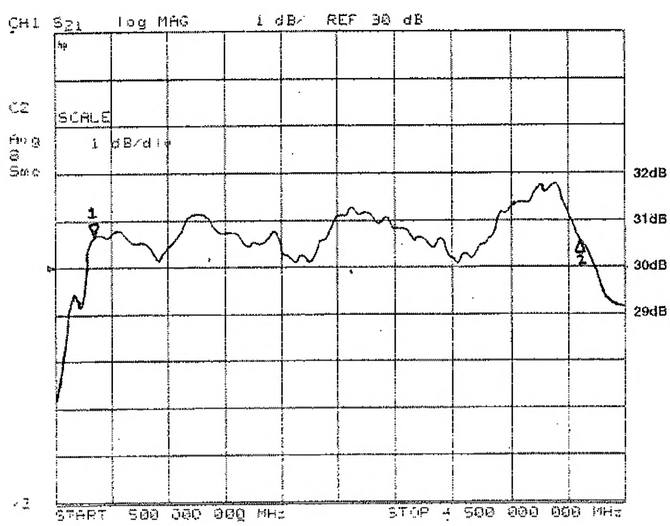

Figure 4.3.8.8
Typical A3 One (1)-Watt Amplifier Response

4.3.8.9 The typical response for the A1 Variable Gain Amplifier (at maximum gain setting) is shown in **Figure 4.3.8.9**.

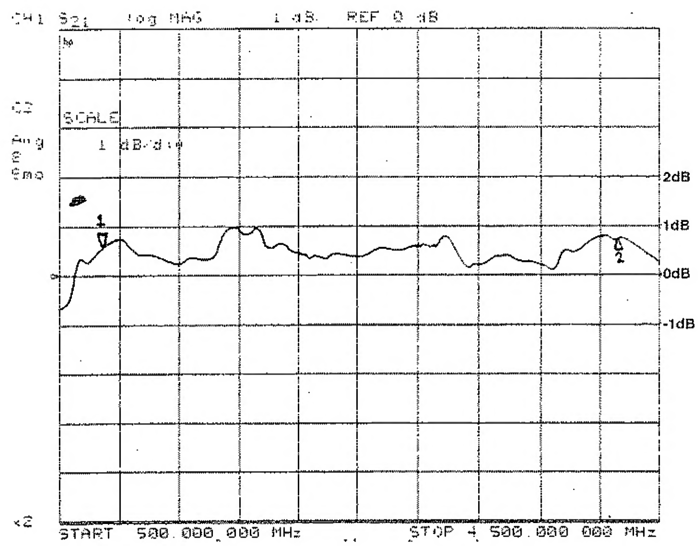

Figure 4.3.8.9
Typical A1 Variable Gain Amplifier Response